2.5. US/CANADA BORDER QUEUE DETECTION SYSTEM

2.5.1. INTRODUCTION

The concept discussed in this section – the US/Canada Border Queue Detection System– supports all corridor travel markets, and the safety and convenience of drivers traveling on I-87 into Canada. This type of highway operations improvement is fully consistent with the Smart Highway and Smart/Safe Traveler goals, and is consistent with the joint New York-Quebec development of the Port of Excellence.

2.5.2. PROJECT DESCRIPTION

The Northbound Queue Detection System is a real-time information system that aids the process of safe travel. The primary purpose of this system is to warn motorists of impending queues ahead, thereby reducing the potential for crashes and providing drivers with information about expected delays. The following presents the existing problems at the northern end of I-87 near the border crossing, and existing and proposed methods of addressing them.

2.5.2.1. Existing Conditions and Deficiencies

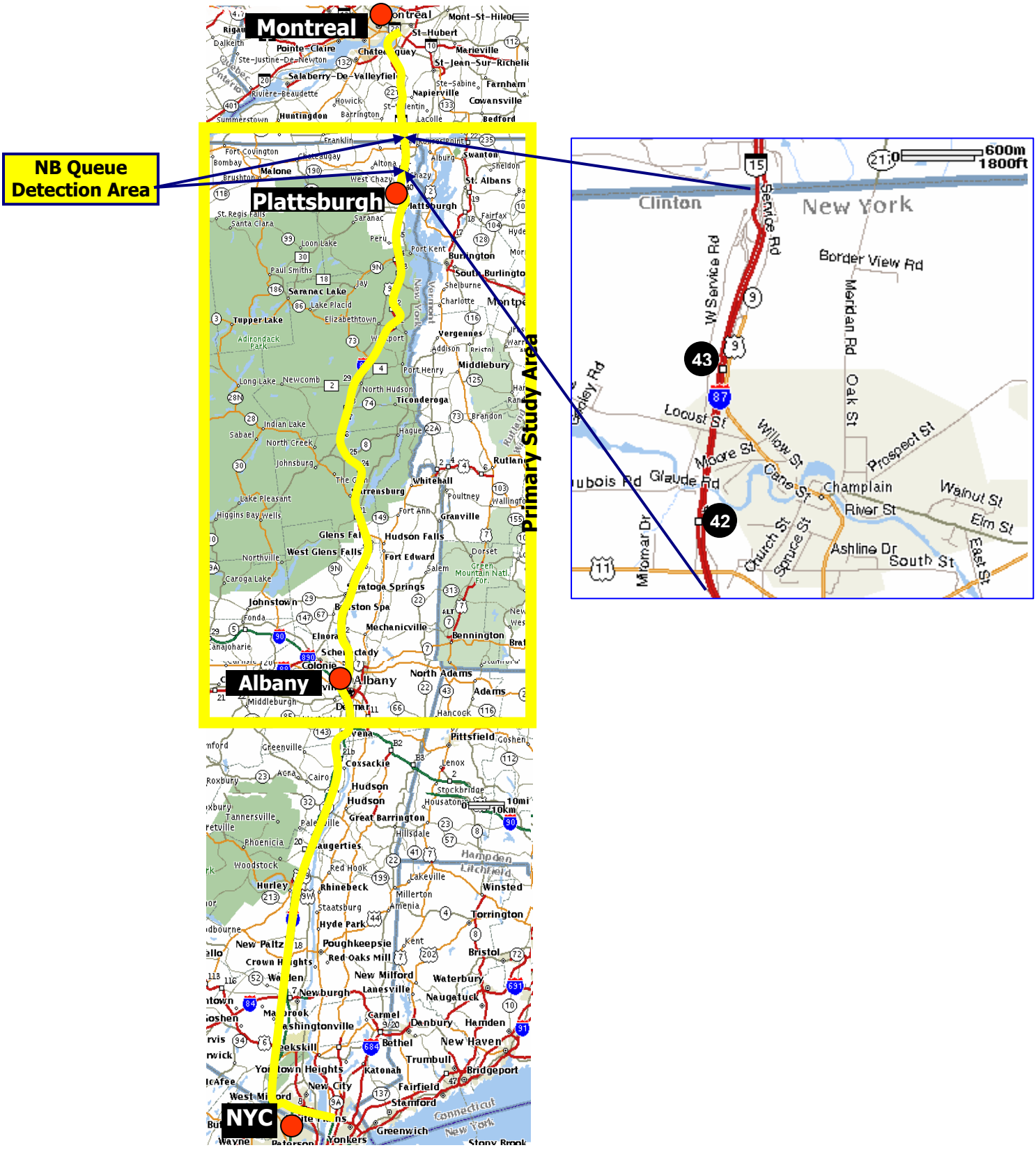
The Champlain/Lacolle border crossing is one of the five busiest US/Canada border crossings. It provides a gateway for direct highway access between New York City and Montreal, among the largest metropolitan areas in the United States and Canada. It also is a link between the Port of New York and New Jersey and the Port of Montreal, two of the largest and most active ports along North America's eastern seaboard. Traffic volumes on I-87 at the border have doubled since 1990 with approximately 15,000 vehicles per day going between the US and Canada.

Since the incidents of September 11, 2001, the northbound I-87 approach to the US/Canada border crossing has experienced increasing security-related traffic delays, which have resulted in vehicle queues on the northbound I-87 mainline approach to the border. The Region 7 office of NYSDOT indicates that at peak times the backups on the mainline typically extend from 0.5 to 1 mile in both northbound approach lanes, while queues extending up to 3 miles occasionally occur. These unexpected queues have become a major safety problem for northbound traffic approaching the border.

The primary cause of the safety issue for northbound motorists is the unexpected change in the driving condition from long stretches of I-87 with minimal to non-existent congestion changing suddenly to a situation with both northbound lanes being blocked by queued vehicles in the travel lanes. The combination of driver inattentiveness, fatigue and sudden change in expectation, combined with high traffic speeds along the northern sections of I-87, leads to a potential for more frequent and severe rear-end type accidents. Queued vehicles sometimes block access to exit ramps at Interchanges 42 and 43, with drivers trying to exit I-87 forced to wait in the border-related queue. The problem from the driver's perspective is further exacerbated by the lack of any "real time" delay information about the length, cause or duration of the traffic queues. The uncertainty of traffic delays is a contributing factor to driver frustration and aggressive driving actions, which may potentially result in further traffic delays and accidents.

Figure 2.5-1 provides the approximate location of the areas of concern at the northern end of the I-87 corridor.

FIGURE 2.5-1
LOCATION OF PROJECT AREA



2.5.2.2. Existing Actions and Programs

The NYSDOT Region 7 office currently operates and maintains a rudimentary queue detection and variable message advanced warning system. The current setup uses queue detectors at two locations on the northbound approach to act as "trigger points" that activate roadside, trailer-mounted variable message signs (VMS). Depending upon the length of the queue, the current system activates one or both of the signs, which alert drivers to the upcoming traffic situation using very basic, pre-programmed scripted text messages. The main limitations of the system are:

- the small size of the VMS, limiting the amount of information that can be provided to drivers;
- the small number of queue detectors;
- the lack of any communication equipment to inform NYSDOT or NYS Police personnel what types of queues have been detected and whether the VMS have been activated; and
- the lack of information for drivers about the duration of the queue or the average processing time at the border crossing.

2.5.3. PROPOSED SOLUTION

2.5.3.1. System Overview

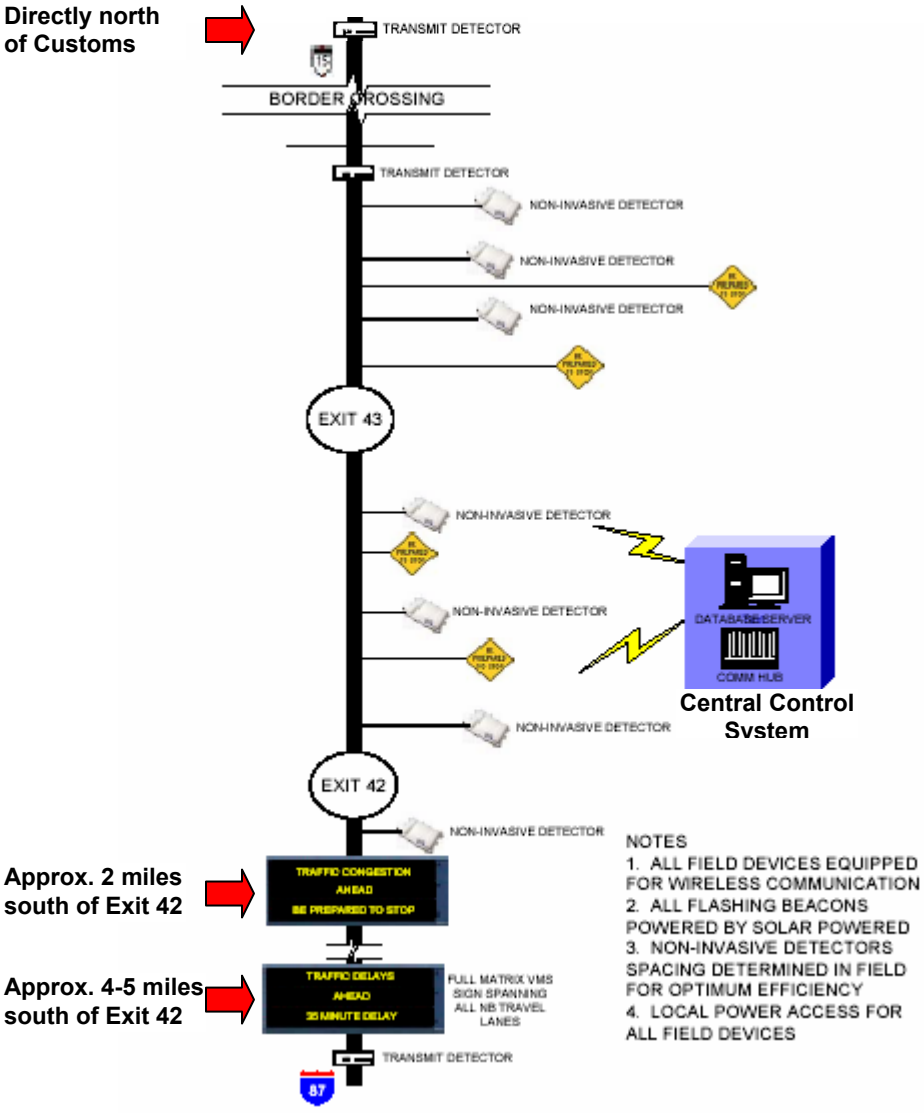
The proposed solution involves the construction of a queue detection system employing reliable, proven state-of-the-art technology, integrated with a technologically advanced system of permanent VMS on the northbound I-87 approach to the US/Canada border. The system would replace the temporary and relatively limited system currently being operated and maintained by NYSDOT Region 7 personnel. The primary function of the proposed system would be to provide a robust automated display system capable of presenting dynamically changing traffic and driver information in "real-time" scenarios. (A similar queue detection system is being developed by Canadian authorities on the southbound Autoroute 15 approach to the border crossing.) All queue-related information would also be directly communicated to NYSDOT offices, provided to Customs personnel at the border, and tied into the Statewide Information Exchange Network (IEN) so travelers elsewhere in the state with access to that network could check on queuing conditions and delays.

2.5.3.2. System Components

Figure 2.5-2 presents a diagram for the proposed permanent queue detection system. The highlights of the proposed system are the following:

- **Queue Detectors**, non-invasive microwave detectors used to determine the presence of slow moving or stopped traffic in the adjacent highway lanes. Microwave radar devices transmit a low energy microwave signal (electromagnetic radiation with a frequency range of 109 to 1011 hertz) at a target area on the pavement, which is then reflected back to the detector. Pulse microwave devices, or radar devices, measure the time it takes for a portion of the microwave radiation to be reflected from the target area to a receiver. Pulse microwave devices can detect volume, presence and occupancy, and are therefore effective as queue detectors. Examples of this type of equipment are provided in Appendix A.

FIGURE 2.5-2
PROPOSED QUEUE DETECTION & TRAVELER INFORMATION SYSTEM



- **TRANSMIT Detectors** to identify vehicles with E-ZPass transponders as they pass through the beginning and end of the queuing zone. Even with the projected low percentage of vehicles equipped with E-ZPass transponders in this segment of I-87 (in the range of 5-10 percent), the recorded data would still be sufficient to estimate travel time between these two points, and to update this data and the related estimates of queue duration at reasonable intervals. There will exist the capability to provide delay information for autos and trucks separately.
- **Flashing Beacons**, equipped with wireless communication capability and solar powered, used to warn motorists of impending queues.
- **Variable Message Sign(s)** to display a variety of messages to drivers entering the queuing zone regarding queue duration.
- **License Plate Recognition (LPR) System Alternative.** The proposed system is using TRANSMIT detectors reading E-ZPass transponders to provide information on the duration of the queue and the length of time to approach and cross the border. The amount of data that system collects depends on how many vehicles have E-ZPass transponders – a relatively low number in this section of New York State. Another option was to use LPR technology to identify vehicles by reading their license plates. Even with only a limited accuracy rate (e.g., 40% - 50%),[1] the number of data points provided would be considerably higher than possible from the TRANSMIT system, given the likely small percentage of vehicles with E-ZPass (expected to be around 5%). However, it was projected that LPR is not well suited to this application, primarily because of the frequently bad weather conditions in the area. Using the cumulative information available on which to make delay estimates -- TRANSMIT data on highway travel time and Customs processing rate, queue detector data, and historical data on delays at this location – delay estimates within a few minutes, with updates every 2-3 minutes, could easily be achieved. Therefore, the TRANSMIT-based system, which is not susceptible to the same weather problems, would be effective even at relatively low E-ZPass usage rates.
- **Bi-Lingual Signage.** Due to its proximity to Quebec, it is recommended that the messages on the VMS signs, and/or the wording on the flashing beacons, would be bilingual (English and French). Options include (1) side-by-side overhead signs, with the message in English on one and French on the other, (2) a single overhead sign that cycles the same message in English and then in French, and (3) separate overhead sign structures for English and French messages. In addition to cost, the key factors to consider in selecting among these options are the speed at which a driver can read a message, and how long the sign will be visible to a driver traveling at highway speeds. A system that cycles the same message in two languages would be least expensive, but would require short, abbreviated messages. The side-by-side design would have higher costs, but could provide more information and give the driver longer to read it. The cost implications of these options are discussed later in this section. The exact method used would be decided as the system moves forward into design.

[1] Under ideal conditions, reading accuracy of over 90% is possible. See Áutomatic License Plate Recognition, Intelligent Transportation Systems, IEEE Transactions on Issues of 2004 (Volume 5, Issue 1 (March 2004).

As shown in Figure 2.5-2, the system would start just north of the border crossing and extend southward along I-87 approximately 3 miles, south of Exit 42. The proposed queue detection system would utilize four types of ITS technologies mentioned above (VMS, TRANSMIT detectors, non-invasive detectors, and flashing beacons) to continuously monitor travel behavior and provide motorists and regulatory agencies with relevant real-time information. The flashing beacons, located at a number of points along the queuing zone, have proven to be a simple and effective tool for this type of advance driver warning situation.

2.5.3.3. Functional Details

The queue detection system would include: seven non-invasive queue detectors, two VMS, and five flashing beacons. In addition, the system would employ three TRANSMIT detectors to determine the travel time between points. All these devices will communicate with the central control system in the field through wireless connections.

The first queue detector would be placed approximately 500 feet from the border crossing processing center. The remaining detectors would initially be evenly spaced, with their location eventually adjusted based on field observations for optimum performance. Factors governing the placement of detectors would be a clear line-of-site view of the lane(s) and easy access to the site to check and maintain equipment. Non-invasive detectors transmit the relevant traffic information (speed, volume and occupancy) once per minute. The detectors compare historical occupancy of the lanes with the measured occupancy to determine the presence of queues, after the necessary "persistence" checks to calibrate the system. (See Appendix A for additional information on the non-invasive detector proposed for this system.)

Three TRANSMIT receivers are proposed for this system. One TRANSMIT receiver would be installed just north of the border crossing processing area, detecting vehicles as they depart from the Customs area. A second transmitter would be placed immediately prior to the Customs area. These two detectors would provide up-to-date information on processing times for crossing the border (trucks and cars). A third TRANSMIT reader would be installed approximately 3 miles south of Exit 42 (see Figure 2.5-2). The data from TRASMIT receivers would be relayed back to the central system, where the travel time data would be compared with historical information. Information on estimated queue duration would then be posted on the VMS – e.g., "Congestion Ahead - 20 Minute Delay."

The proposed VMS -- "full matrix" signs capable of presenting twice the information of portable VMS equipment -- would span across all northbound travel lanes on I-87. A library of relevant messages will be developed for display on the VMSs. It is assumed that the two signs would be located south of Exit 42. The first sign – probably 4-5 miles south of the exit -- would provide drivers with their first up-to-date information about conditions at the border and the opportunity to think about possible options. The second VMS – most likely 2 miles south of Exit 42 – would provide an update on conditions, in sufficient time to make a decision on whether to get off the highway (e.g., get gas, lunch, etc.) or proceed to the border.

Different VMS Options. The proposed system could have a single VMS sign, most likely located 4 miles south of Exit 42. While this would reduce costs by roughly 12% -15% compared with the 2-sign system, it would reduce the system's flexibility, the amount of information that travelers could be given and when they receive it. Given these factors, the two-sign option is preferred. Another option -- placing one VMS south of Exit 42 and the second between Exits 42 and 43 – was also considered. However, the short distance between these exits, and the likelihood that under peak queuing conditions the driver would already be in the

queue, would make this option less effective in providing drivers with useful information at a time when they would have the option to use it.

Solar-powered flashing beacons with a wireless link with the central control system would be used to alert motorists of queues. As shown in Figure 2.5-2, the first flashing beacon would be south of the second queue detector from the border crossing and tied into the central control system, which would control their operations. When traffic starts queuing past the first detector from the north, the flashing beacon immediately to the south of second detector would be activated. A similar methodology would be employed for all flashing beacons. A typical setup for a flashing beacon station is shown in Appendix A. It is likely that bi-lingual messages would be used on these beacons.

The central control system software proposed for this system would be the "brain" of the proposed queue detection system. This central control system would use historical travel time and queuing information, occupancy thresholds for queues, and a library of messages to control the content displayed on the VMS and trigger the flashing beacons. A relational database management system would be used to ensure data persistence, transaction integrity, data integrity, rollback capability, and continual operations. The database would store both static and dynamic data on travel time and occupancy. Data archiving service would also be developed to ensure smooth system recovery in case of major system failures. The central system would be able to communicate with the IEN, so that kiosks along the I-87 corridor, web-based corridor information, and other related ITS systems could provide real-time information about border delays.

2.5.3.4. Functional Specifications

Item	Specifications
Non-invasive Detector	1. Low power requirements and field hardened for harsh conditions 2. Capture vehicle data including speed, volume and occupancy 3. Communicate with local hub via a wireless link
TRANSMIT	1. Low power requirements and field hardened for harsh environment 2. Communicate with local hub via a wireless option
Variable Message Sign	1. Full matrix walk-in sign spanning all travel lanes of NB I-87 2. Communications with local hub via a wireless option
Flashing Beacons	1. Solar powered 2. Communicate with the central hub via a wireless link
Communications Infrastructure	1. Communications with local hub via a wireless connection
Central System	1. Wireless communication with field devices 2. Compatible with IEN

2.5.4. PROJECT IMPLEMENTATION

The goal of the proposed project is to replace the existing temporary system with a more technologically advanced permanent queue detection system integrated with a dynamic variable message system. During system installation, a temporary VMS could be used while the permanent, larger signage is being constructed. Otherwise, it is projected that the entire proposed system would be installed in a single phase. As noted above, the information collected from the queue detection system, and related estimates of delay at the border, could be easily

distributed to remote sites in the corridor (i.e., travel kiosks) or over alternative communication sources (i.e., HAR, cellular communications, web-based systems, etc).

2.5.4.1. Regulatory, Environmental, and Agency Coordination Issues

Because this project would be constructed entirely within the I-87 ROW and result in minimal environmental disturbance or consequence, regulatory requirements and environmental processing would be minimal. Inter-agency coordination between the stakeholders (i.e., NYSDOT, NYS Police, US Customs and Border Patrol, MTQ, Canadian Border Services Agency) would be necessary to ensure the functionality of the system and that appropriate response protocols are in place and defined. For example, border crossing personnel could be informed when particularly large queues are formed, giving them the option to re-assign processing staff if possible to help reduce traveler delays. It is projected that similar sharing of information would occur between MTQ and US Customs to help manage southbound queues on Autoroute 15.

Depending on availability, it is expected that the system would use CDMA (Code Division Multiple Access) cell phone-type communications to link most of its various field equipment with its central control system, IEN and other locations. Some local short-distance microwave communications would also be used (e.g., to communicate with the emergency flashers). Some of the proposed system's elements may use wireless communication methods requiring licensing approval by the Federal Communications Commission (FCC) and possibly the Canadian Communications Establishment (CCE). These approvals are typically obtained by the vendors of the various communications equipment, and are normally not a source of delay.

2.5.4.2. Projected Costs

The total cost of implementing this system would be approximately $2 million (see table). If a side-by-side VMS system were used to provide English and French messages, with two separate displays placed on each structure, the costs would rise to approximately $2.2 million. The annual maintenance costs, at approximately 2% of capital costs, would be approximately $30,000 to $35,000 per year. Operating costs would be approximately $8,000 to $9,000, including approximately $2,500 for power, $1,500 for communications and $4,500 - $5,000 for staff.

A portion of the funding for this initiative has potentially been identified by NYSDOT. Other funding could potentially be sought, if needed, under Federal ITS or Trade Corridor programs.

Projected Costs for Queue Detection System				
Description	**No.**	**Unit Cost**	**Total Cost**	
Non-invasive Detector & Assoc. Equipment	7	$40,000	$280,000	
TRANSMIT Detector [1]	3	$125,000	$375,000	
Field cabinet and accessories	1	$50,000	$50,000	
Power Supply	1	$150,000	$150,000	
VMS [2]	2	$250,000	$500,000	
Communications/Control Equipment	1	$100,000	$100,000	
Wireless Commun. (5 Years)	1	$28,800	$28,800	
Software	1	$35,000	$35,000	
Sub-total: Equipment (Installed)				$1,518,800
Miscellaneous Equipment				$40,000
Sub-total:				$1,558,800
Design & Misc. (Incl. Contingency)	25%			$389,700
		Grand Total		$ 1,948,500
**With Side-by-Side English/French Signs		Grand Total		$ 2,198,500
Approximately $2.0 - $2.2 million				
[1] The costs for the TRANSMIT detector, which would cover multiple lanes, was provided by TRANSCOM, and includes detectors, controllers, cabinets, structures, foundations, etc. [2] VMS costs include the costs of the supporting structure, cabinet, controller, foundations, etc. It was assumed that a sign of the size required in this application, could not be supported by a lower-cost cantilevered sign structure.				